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TRANSMITTAL FORM

(to be used for all correspondence after initial filing)

Application Number	10/042,475
Filing Date	January 9, 2002
First Named Inventor	Kenneth E. Dahlberg
Group Art Unit	2128
Examiner Name	Saif A. Alhija
Attorney Docket Number	PM 98.086

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ENCLOSURES *(check all that apply)*

☐ Fee Transmittal Form	☐ Drawing(s)	☐ After Allowance Communication to Group
☐ Fee Attached	☐ Licensing-related Papers	☒ Appeal Communication to Board of Appeals and Interferences
☐ Amendment / Response	☐ Petition	☐ Appeal Communication to Group **(Appeal Notice, Brief, Reply)**
☐ After Final	☐ Petition to convert a Provisional Application	☐ Proprietary Information
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SIGNATURE OF APPLICANT, ATTORNEY OR AGENT

Firm or Individual Name	J. Paul Plummer, Reg. No. 40,775 ExxonMobil Upstream Research Company
Signature	J. Paul Plummer
Date	April 14, 2006

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Date	April 14, 2006

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

IN RE APPLICATION OF KENNETH E. DAHLBERG

"VOLUMETRIC LAMINATED SAND ANALYSIS "

On Appeal from the decision of the Examiner Mailed January 18, 2006,
finally rejecting Claims 1 - 12, and the
Advisory Action Mailed March 14, 2006

Examiner Saif A. Alhija Group Art Unit 2128

APPEAL BRIEF

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PATENT & TRADEMARK OFFICE

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF APPEALS AND INTERFERENCES

In re application of Kenneth E. Dahlberg	§ § §	Confirmation No.: 6077
Serial No. 10/042,475	§ §	Examiner: Saif A. Alhija
Filed: January 9, 2002	§ §	Art Unit: 2128
"Volumetric Laminated Sand Analysis"	§	

MS: AF
Commissioner for Patents
P. O. Box 1450
Alexandria, VA 22313-1450

APPEAL BRIEF

Sir:

Appellant previously filed a Notice of Appeal under 37 C.F.R. § 1.191 from the decision of the Examiner dated March 14, 2006 with respect to the above-identified patent application. Appellants hereby submit this Appeal Brief in support of Appellant's position on appeal.

REAL PARTY IN INTEREST

The real party in interest is ExxonMobil Upstream Research Company, assignee of the Applicant under assignment recorded June 25, 2003 at Reel 013756, Frame 0091.

RELATED APPEALS AND INTERFERENCES

There are no other appeals or interferences known to Appellant or Appellant's assignee, ExxonMobil Upstream Research Company, which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

STATUS OF CLAIMS

Original claims 1-12 have never been amended, all have been given final rejection, and all are being appealed.

STATUS OF AMENDMENTS

There are no pending amendments.

SUMMARY OF THE CLAIMED SUBJECT MATTER

The application has a single independent claim, claim 1, which claims a method of analyzing well log data from thinly inter-bedded sandstone and shale reservoirs [see Figs. 1 or 5, and ¶**28**] to obtain estimates of hydrocarbon pore volume. In the method, a model of the reservoir is established for an interval that is to be analyzed. Within the analysis interval [**42** in Fig. 5], a set of bed types is identified which are assumed to make up the interval. In the example of Fig. 5, there are three bed types: a high quality sandstone **36**, a low quality sandstone **38**, and shale **40**. Figure 1 shows examples of different aspect ratios (ratio of bed thickness to width; see ¶**28**.) in an analysis interval with two different bed types, sand **10** and shale **12**. In the top interval of Fig. 1, the aspect ratio for parallel, planar beds is 0; the other two intervals illustrate aspect ratios >0 but <1 (spherical). For each bed type, parameter values such as aspect ratio and porosity are estimated from whatever information may be available [see ¶**32** and Fig. 6]. Similarly, the frequency of occurrence of each bed type in the analysis interval may be estimated [¶**9** and *frac* values in Fig. 7]. Equations are then selected [¶**41**] that can predict the result of well log measurements such as conductivity logs, for which data exist for the subject area, from the estimated bed-type parameters such as porosity, water saturation and aspect ratio. These

equations are then inverted, using Monte Carlo methods [¶36]. This amounts to forward solving the equations for the well log parameters, assuming bed-type parameter values sampled from a range or probability distribution of estimated values. The calculated well log values are compared to the measured values. This is repeated several times for different samplings of the estimated bed-type parameter values. From this, the values of the bed-type parameters most consistent with the well log data are determined. From these best values of the bed-type parameters, the hydrocarbon pore volume can be calculated [¶41]. The Monte Carlo set of solutions yields a statistical distribution and a corresponding uncertainty for the final result [¶37].

A key feature of the present inventive method is that the model of estimated parameter values (e.g., porosity, etc.) that is inverted by Monte Carlo methods is not a point-by-point model of the interval to be analyzed such as is taught in the Malinverno reference ("Malinverno"). Instead, the problem of many thin layers of variable aspect is reduced to workable dimensions by dealing with a few bed types [¶32, step 1(b)], and estimating the makeup of the interval in terms of the identified bed types. In a further computational efficiency step, in some embodiments the measured well log data are averaged over the analysis interval, and the comparison of forward-modeled values to measured well log data are made on using average values [¶9 (lines 11-12) and ¶40 (lines 1-3)].

GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

Based on careful reading of the Final Office Action mailed Jan. 18, 2006 and the Advisory Action mailed Mar. 14, 2006, Appellant believes that the Examiner's grounds for rejection (particularly of claims 1-3) that Appellant chooses to dispute in this appeal can be summarized by the single statement:

1. Malinverno (WO 00/48022) discloses in his modeling technique (a) the use of bed types (and bed-type parameters) in his modeling; (b) averaging well log data across the analysis interval; or (c) how to treat layers of finite lateral extent using the parameter aspect ratio.

Appellant disagrees with many other grounds for rejection of various claims, but for purposes of this appeal will focus on the above stated grounds, because if Appellant is correct, other grounds are moot, and because the Examiner regards these issues as central in his Advisory Action comments, which read:

> "Applicant's arguments filed 21 February 2006 assert that the Malinverno reference does not suggest bed types, average values, as well as finite extent aspect ratio. Malinverno discusses on page 8, paragraph 2 a "layered earth with material properties" which meets the definition of bed types, as defined in the specification. Malinverno discloses finite extent aspect ratios as opposed to an infinite extent aspect ratio. It is noted that the applicant appears to be reading in limitations that are not recited in the claims, such as the issue of computing resources. It is also noted that Applicant has stated on page 1, paragraph 2 of Applicant's arguments that the Malinverno reference could be used to address the Applicant's invention."

ARGUMENT

(All claims) Malinverno's method is very general, compared to Appellant's, in terms of the technical problem it addresses. Malinverno thus does not exclude application of his modeling method to a "subsurface geological formation having thinly interbedded sandstone and shale layers" [quote from Appellant's claim 1], nor does he state that aspect ratio cannot be a model parameter or that layers (beds) of finite lateral extent cannot be treated. However, he does not disclose or suggest any techniques for dealing with these two geological features, which are main objects of Appellant's invention. In particular, as will be documented below, he neither teaches nor suggests a method involving classifying all beds into bed types, each bed type characterized by bed-type parameters, with beds of finite lateral extent dealt with by including bed aspect ratio among the bed-type parameters. These features not disclosed in Malinverno appear as express limitations in Appellant's claims 1 and 2.

Also, Malinverno neither teaches nor suggests averaging the measured data over the analysis interval before analyzing. [See Appellant's claim 3, step (b).]

The Examiner asserts in the Advisory Action that the issue of computing resources is not recited as a claim limitation. It is not, but neither is this feature relied upon by Appellant to distinguish Malinverno in a § 102 sense; instead, the main claim features relied upon are summarized above. Appellant's observation about needing enormous computing resources to deal with many thin beds of finite lateral extent by conventional, explicit methods is offered only to show the practical utility and advantages of Appellant's inventive method as compared to the prior art such as Malinverno. A further advantage of the present inventive method is that Malinverno would need (in addition to enormous computing resources) high resolution well log or other measured data to analyze. [See ¶4 of the present application regarding the problems with using standard, low resolution, well logging results in prior art methods – such as Malinverno's -- to estimate pore volume.] Appellant's method provides a way to get around these limitations, using standard (low-resolution) well log data. [See ¶5, and ¶8 lines 1-5, of the present application.]

The Examiner's final remark in the Advisory Opinion quote above is a misstatement of what Applicant actually wrote, which was that Malinverno's method could, however inefficiently, be applied to the thin-bed technical problem addressed by the present invention, but it would lack the [novel] features of the present invention. This was a remark of a background nature made about a difficult technical area in an attempt to be helpful.

(Claim 1) The Examiner contends that Malinverno does disclose "bed types" on page 8, paragraph 2, where he mentions a "layered earth with material properties." This cryptic passage supports an opposite conclusion: that Malinverno needs to represent each layer explicitly in his model. If there are hundreds of thin beds in an analysis interval, Malinverno needs to have a fine enough discrete grid such that the hundreds of thin layers are resolved. This is all that can be read from page 8, paragraph 2, of Malinverno, or anywhere else in the publication. There is not even a

suggestion that this task can be simplified by identifying that the hundreds of thin beds may consist of either shale or sandstone thin beds, and that each *bed type* (shale or sandstone) can be represented by a single set of average *bed-type parameters*, instead of a separate set of parameters for each bed. Nor is there even a suggestion that the model can be "based upon estimates of bed types and bed-type parameters in the formation" [Appellant's claim 1], i.e. that the model can use estimated frequencies of occurrence of each bed type in the analysis interval instead of representing each thin bed explicitly. The Examiner also cited page 1, paragraph 3, and page 2, paragraph 1, as disclosing step (a) of the subject application's claim 1. The page 1 passage contains only the most general observations about subsurface models. The page 2 paragraph discloses the opposite of Appellant's claimed method. The paragraph discloses that a reservoir model contains geometrical model parameters that "typically identify geological boundaries, such as contacts between different geologic layers . . ." In his Fig. 3, Malinverno gives examples of such a layered model (**42**, **46**, **50** and **54**). There is nothing to even suggest that the layers should be classified into common bed-types, such as is plainly apparent in Appellant's Figs. 1 and 5-8.

Step (a) of Appellant's claim 1 clearly specifies a model based on bed type classification: "defining an initial model of the subsurface formation based upon estimates of different bed types and bed-type parameters in the formation . . ." In contrast, Malinverno teaches a model that provides an explicit representation of subsurface layers.

The situation is the same with aspect ratio, another feature required in Appellant's claim 1: "one of said bed-type parameters being aspect ratio . . ." The Examiner asserts that Malinverno "discloses finite extent aspect ratios as opposed to an infinite extent aspect ratio." The Examiner appears to cite (in connection with claim 2) only the previously discussed second paragraph of page 8 in connection with "a positive aspect ratio." Yes, it is possible that an "irregular 3D grid" or a "geometry based model" could be used to display layers with aspect ratios greater than zero, i.e. finite lateral extent. But, if so, that would again be done by explicit representation of such bodies in Malinverno's model, and not by incorporating the feature into the

model as another bed-type parameter called aspect ratio as is taught by the subject application and required by the claims. There is no hint of the latter treatment in Malinverno. Appellant finds no mention of *aspect ratio* or any synonymous term in Malinverno.

Malinverno does not disclose step (a) of Appellant's claim 1 because it neither discloses nor suggests a geologic model based on bed types and bed-type parameters (including aspect ratio). Malinverno cannot disclose Appellant's steps (b) and (c) because they involve inverting a *bed-type* model (not just any geologic model), and making determinations from that. Malinverno clearly cannot anticipate Appellant's claim 1, meaning that all of Appellant's claims are patentable over Malinverno.

(Claim 3) Claim 3 includes the feature of *averaging* well log measurements (such as electrical conductivity) over the analysis interval, and then calculating such well log quantities from the equations relating bed-type parameters to well log measured quantities. Then, the measured and calculated quantities are compared, and the model parameters (bed-type parameters) are adjusted ("updated") based on the comparison. The process is repeated until a convergence criterion is met or other stopping point is reached. It should be understood that claim 3 describes a preferred method for obtaining an *initial* model that will be close to the right answer, so that the Monte Carlo repetitions can be more focused and fewer in number. [See **¶9** in the application.] The Examiner cited various passages in Malinverno as disclosing the particular feature (b) of claim 3: "obtaining average values of the measured well log data over the analysis interval." Appellant respectfully disagrees. (a) The Examiner cites Figs. 1 & 2. These are a flow chart and a computer schematic diagram. The flowchart shows "measurement data" being used to "update model." The drawings are too general to have any relevance to whether the measurement data are averaged over the analysis interval. (b) The Examiner cites page 4, paragraph 1, the last two lines. These two lines read: "Alternatively, one can use a Monte Carlo method to obtain a sample of models drawn from the posterior PDF [probability density function]. This sample of models spans the uncertainty implied by the measurements." This passage has no connection to the subject matter of Appellant's

claim 3, and must have been cited by mistake. (c) The Examiner cites page 4, paragraph 2, last line, which reads: "We also show how to update a sample of models obtained by the Monte Carlo method to include new information." This says nothing about averaging the measurement data over the analysis interval before using it in the updating process. (d) The Examiner cites page 8, paragraph 2. This paragraph discusses, in very general, terms, what Malinverno's subsurface model consists of. It does not discuss how this model may be refined by comparison to measured well log data. Appellant must respectfully conclude that Malinverno neither discloses nor suggests Claim 3's feature of averaging the measured well log data over the analysis interval.

FEES

The Commissioner is authorized to charge the requisite fee of $500.00, and any additional fees which may be required, to Deposit Account No. 05-1328.

SUMMARY

Appellant contends that the preceding discussion demonstrates that the Examiner has misunderstood Malinverno, or the present application, or both. Appellant further contends that the grounds for rejection are accordingly incorrect, and all of Appellant's claims are novel over Malinverno. It is not necessary to discuss the obviousness rejections of claims 7 and 9 because they are patentable as claims depending on a valid independent claim. Therefore, Appellant respectfully requests the Board to overrule the final rejections of claims 1 - 12 and to direct allowance of these claims.

Respectfully submitted,

Date: April 14, 2006

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Monica Stansberry

CLAIMS APPENDIX

The claims involved in the present appeal are as follows:

1. A method of analyzing data obtained from well logs taken in a subsurface geological formation having thinly interbedded sandstone and shale layers to determine an expected value of the hydrocarbon pore volume of the formation, comprising:

(a) defining an initial model of the subsurface formation based upon estimates of different bed types and bed-type parameters in the formation, one of said bed-type parameters being aspect ratio, the initial model including a system of log equations for predicting well logs from bed-type parameters;

(b) performing a Monte Carlo inversion to find the ranges of bed-type parameters consistent with the measured well log data; and

(c) determining a statistical distribution for hydrocarbon pore volume representing the expected value for and an uncertainty in the hydrocarbon pore volume from said Monte Carlo inversion.

2. The method of claim 1 wherein at least one of said bed types has a finite lateral extent and a positive aspect ratio.

3. The method of claim 1 wherein the step of defining the initial subsurface formation model comprises:

(a) selecting an analysis interval;

(b) obtaining average values of the measured well log data over the analysis interval;

(c) formulating a set of reservoir and non-reservoir bed types constituting the selected analysis interval;

(d) determining average values of the petrophysical parameters for each bed type;

(e) assigning relative frequency of occurrence of the different bed types in the formation;

(f) computing log responses for each bed type and over the composite analysis interval;

(g) comparing the computed log responses to the measured log data for consistency; and

(h) repeating steps (b) to (g) until the model parameters are consistent with the measured log data.

4. The method of claim 1 wherein the step of performing the Monte Carlo inversion comprises:

(a) estimating uncertainty ranges for each bed-type parameter and for bed frequencies;

(b) generating a random model consisting of random variants for each bed-type parameter and frequency;

(c) computing estimates of average log responses over an analysis interval of the model;

(d) comparing estimated log responses to measured log responses for consistency;

(e) retaining the model only if estimated log responses are consistent with measured log responses;

(f) repeating steps (a) to (e) until a specified number of trials has been completed; and

(g) computing distribution statistics for interval hydrocarbon pore volume and related parameters.

5. The method of claim 1 wherein the step of performing the Monte Carlo inversion includes estimating uncertainties for the formation bed properties and for the volume fractions.

6. The method claim 1 wherein the step of performing a Monte Carlo inversion is carried out using a programmed digital computer.

7. The method of claim 1 wherein the formation model has inputs which comprise a set of parameters describing the thinly bedded formation and has outputs which are the formation average porosity, average water saturation, sand fraction, and average hydrocarbon pore volume.

8. The method of claim 7 wherein the accuracy of the input parameters of the formation model are described in terms of probability distributions of parameter values and wherein the step of performing a Monte Carlo inversion involves making a plurality of cases wherein each case comprises a random selection of a parameter value for each input parameter from the probability distribution and calculating a set of outputs.

9. The method of claim 8 wherein the step of performing a Monte Carlo inversion is made using a spreadsheet programmed in a digital computer and wherein each case involves a recalculation of the spreadsheet to obtain a resultant set of outputs.

10. The method of claim 9 wherein the step of performing a Monte Carlo inversion involves making at least one thousand cases and each resultant set of outputs comprises calculated log responses.

11. The method of claim 10 wherein the resultant set of outputs from each case is retained only if that case produces a set of calculated log response outputs which correspond to the input log values within a specified closeness of fit.

12. The method of claim 11 further comprising the step of storing the retained sets of outputs and analyzing them for a determination of uncertainty in the estimate of hydrocarbon pore volume.